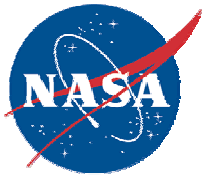
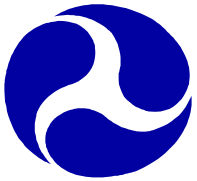
NASA AATT HITS Program
(Helicopter In-flight Tracking System)

FAA Safe Flight 21 En Route and Oceanic Applications

April 28, 2004





Briefing to:

NASA ICNS Conference
Surveillance Session

Prepared by:

Chris Daskalakis
Patrick Martone
U.S. DOT Volpe Center
Surveillance and Assessment Division (DTS-53)

HITS I Overview

- **Period: 2001 and 2002**
- **Participants: NASA, Volpe, Sensis**
- **Function: Surveillance using 2 technologies:**
  - Wide Area Multilateration (WAM)
  - Automatic Dependent Surveillance – Broadcast (ADS-B)
- **Purposes:**
  - Engineering 1: WAM concept validation
  - Engineering 2: Effectiveness of WAM and ADS-B over water
  - Operational: Test acceptability of WAM as helicopter flight following system

HITS I Coverage

Coverage areas

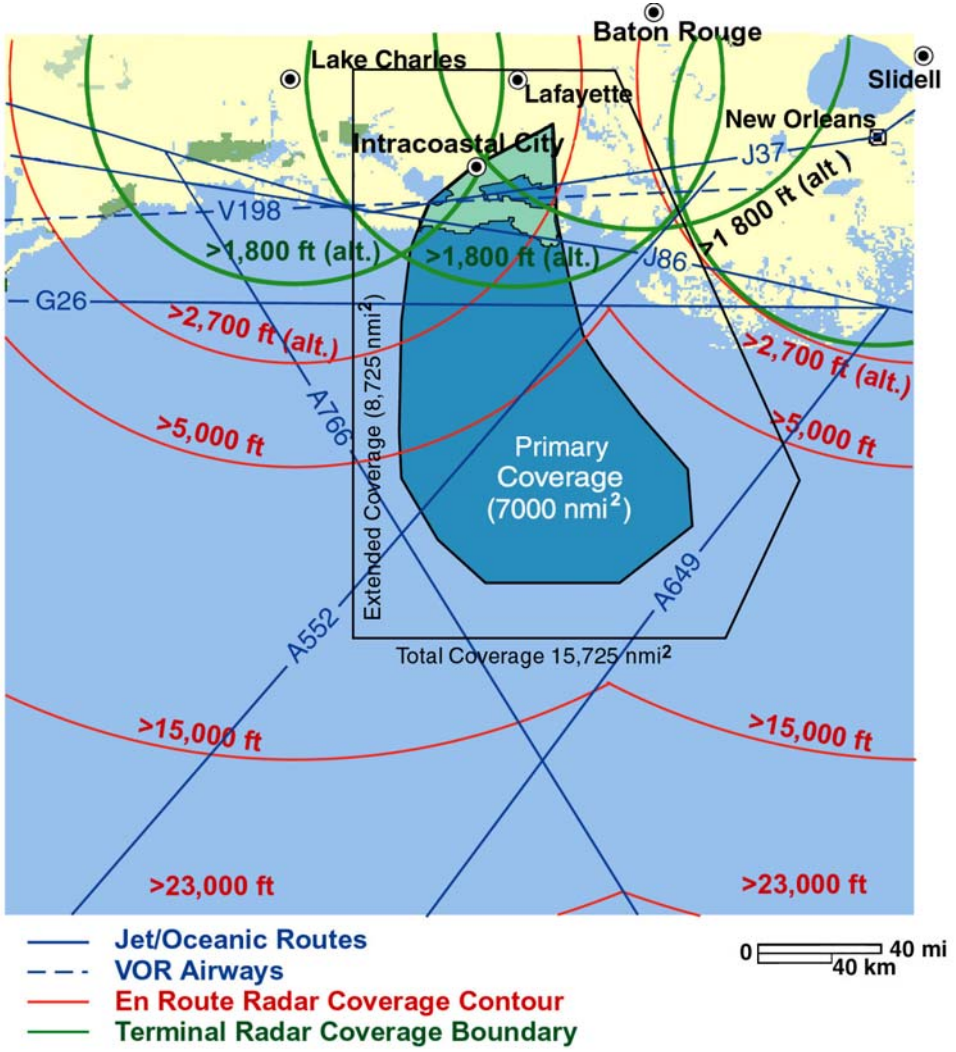
- "Primary" (containing ground sites) — 7,000 nmi² above 100 ft altitude
- "Extended" — 8,725 nmi² above 1000 ft
- Additional at higher altitudes

En route radars

- Lake Charles
- Slidell

Terminal radars

- Lafayette
- Lake Charles
- Baton Rouge
- New Orleans



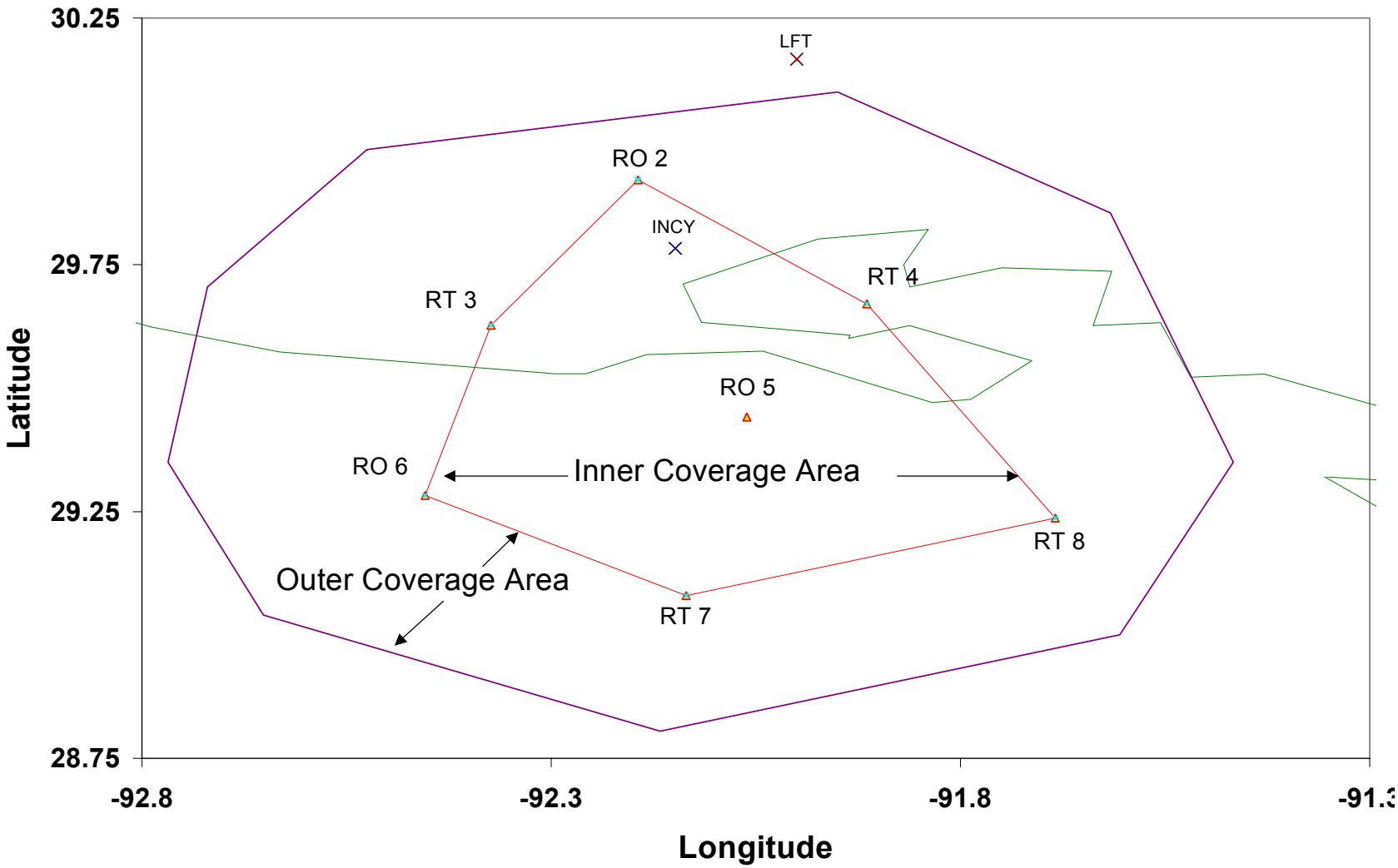
HITS II Overview

- **Period: 2003 and 2004**
- **Participants: NASA, FAA, Volpe, Sensis**
- **Functions: Surveillance using 2 technologies:**
  - Automatic Dependent Surveillance – Broadcast (ADS-B)
  - Wide Area Multilateration (WAM)
- **Purposes:**
  - Operational 1: Demonstrate continuous surveillance between U.S. (central Gulf coast) and Mexico (Yucatan)
  - Operational 2: Test validity of WAM for terminal area helicopter operations
  - Engineering 1: Demonstrate effectiveness of ADS-B over very wide area (400,000 nmi^2)
  - Engineering 2: Test WAM over very wide area

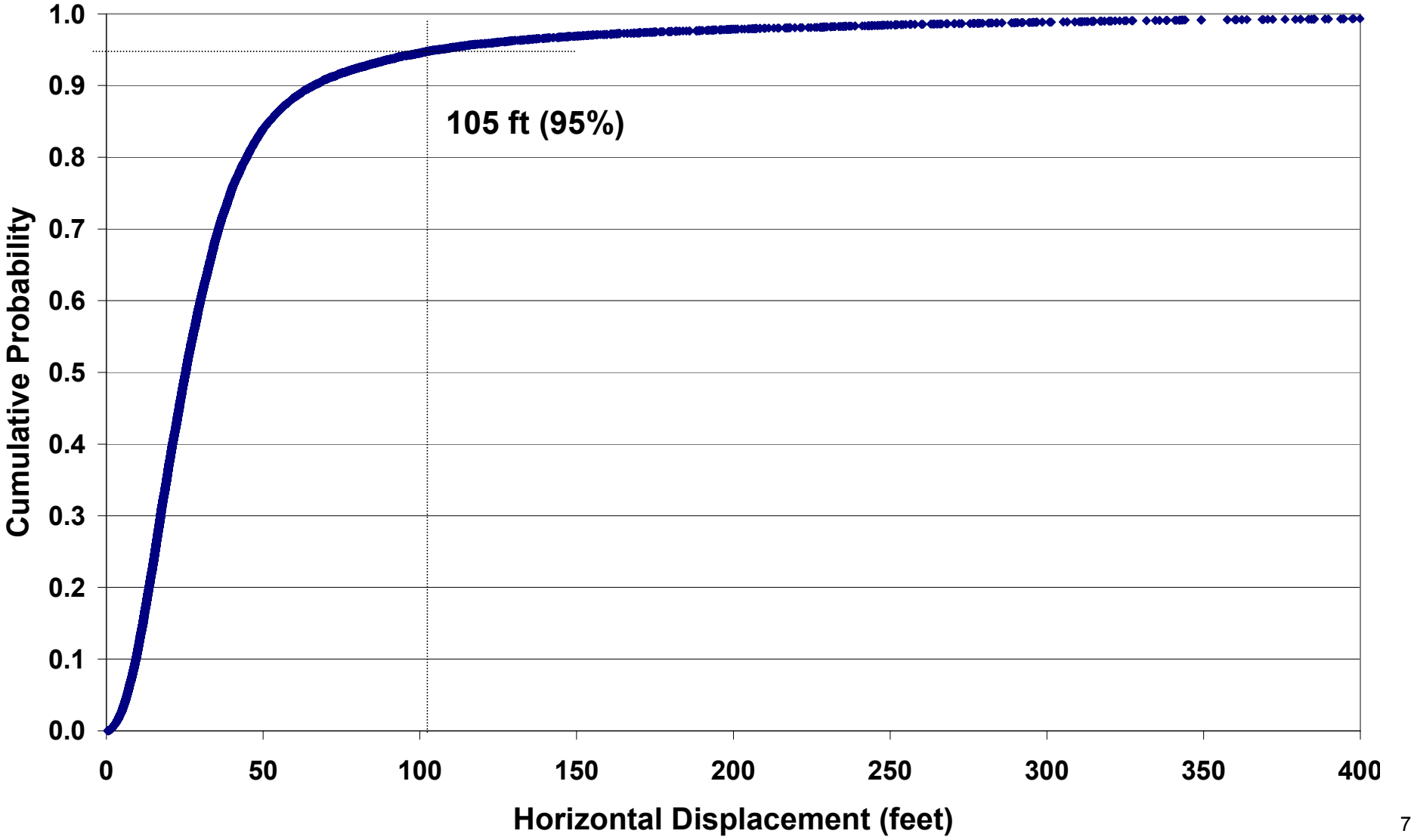
Multilateration Terminal Area System Overview

- **Controlled flight tests of the terminal area system at Intracoastal City, LA conducted June 10 to June 12, 2003**
- **Two rotary wing aircraft (Bell 206 Long Ranger) leased from Petroleum Helicopters, Inc.**
  - Aircraft flew predefined flight segments below 10k feet
  - Tests conducted using discrete and non discrete beacon codes
  - Aircrafts' ATCRBS (Mode A/C) transponders checked with portable test set each morning
  - Transponder "swapped out" on Tail # N906PH after June 10 flight test
    - Higher power transponder – 600 Watts
      - Original transponder output measured at 300 Watts from transponder test kit
    - Questionable performance
- **Government evaluated HITS performance qualitatively for discrete targets in the following categories:**
  - Positional Accuracy
    - Nominal Errors
    - Large Errors (False Targets)
  - Update Interval
    - Horizontal Position
    - Beacon (Mode A) Code
    - Altitude (Mode C) Code
  - Probability of Detection
    - Total percentage of position reports received within five seconds
  - Coverage Volume
  - Target Resolution

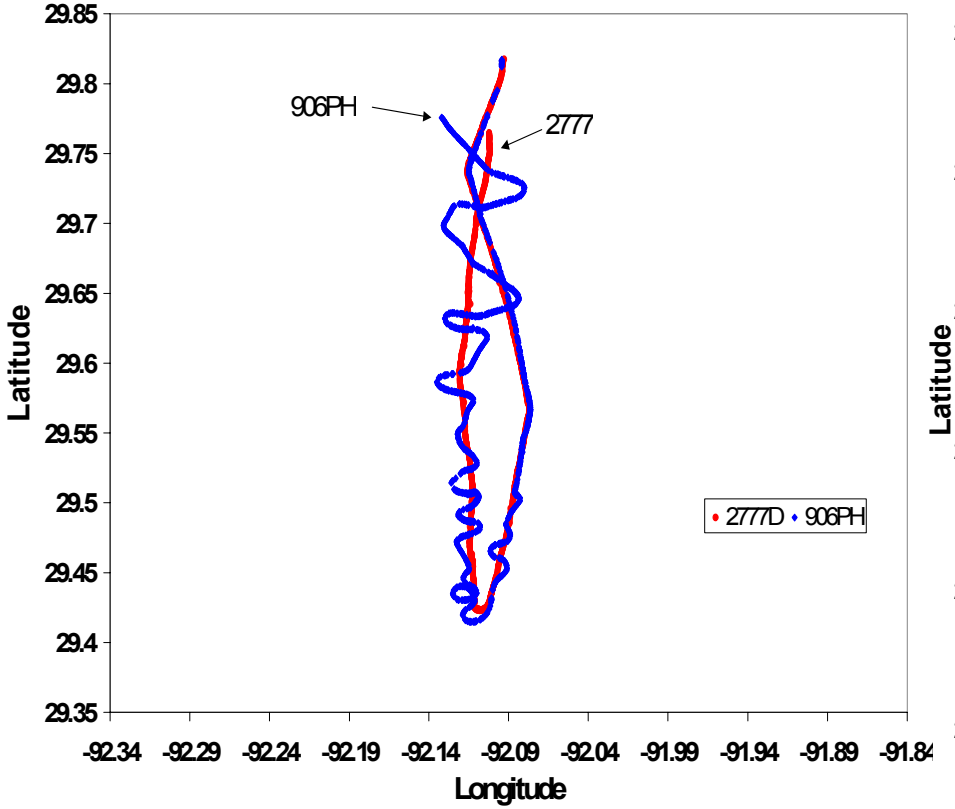
INCY Coverage Area

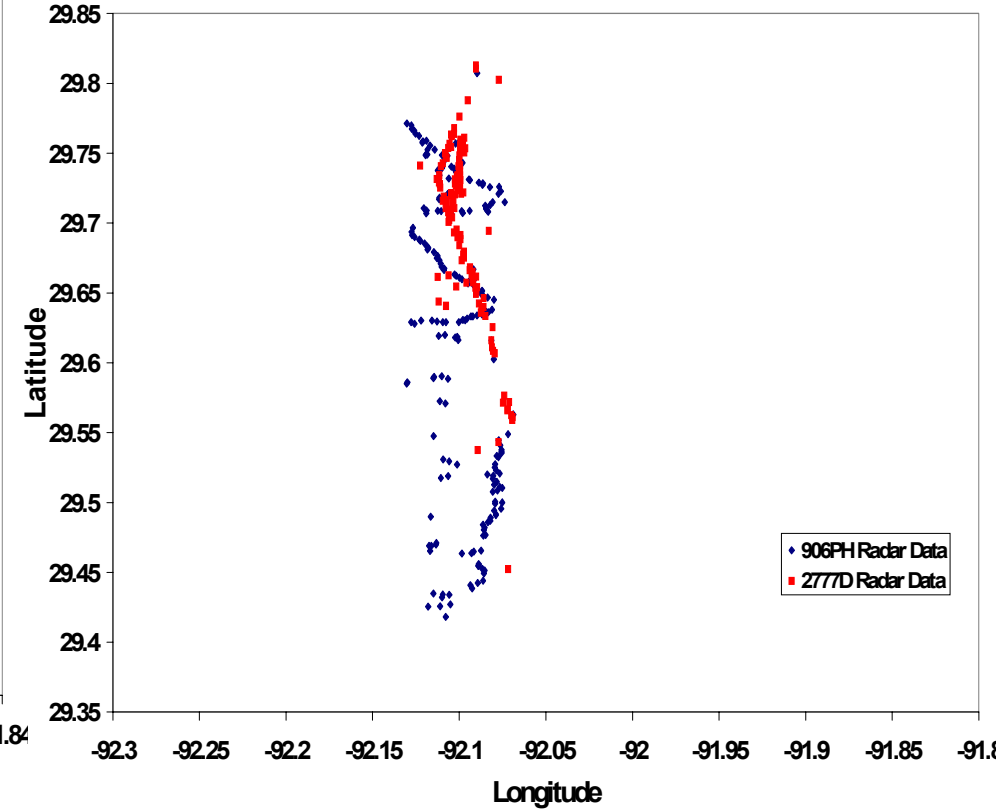


Horizontal Difference Cum. Prob.
(HITS Multilateration) – (GPS)

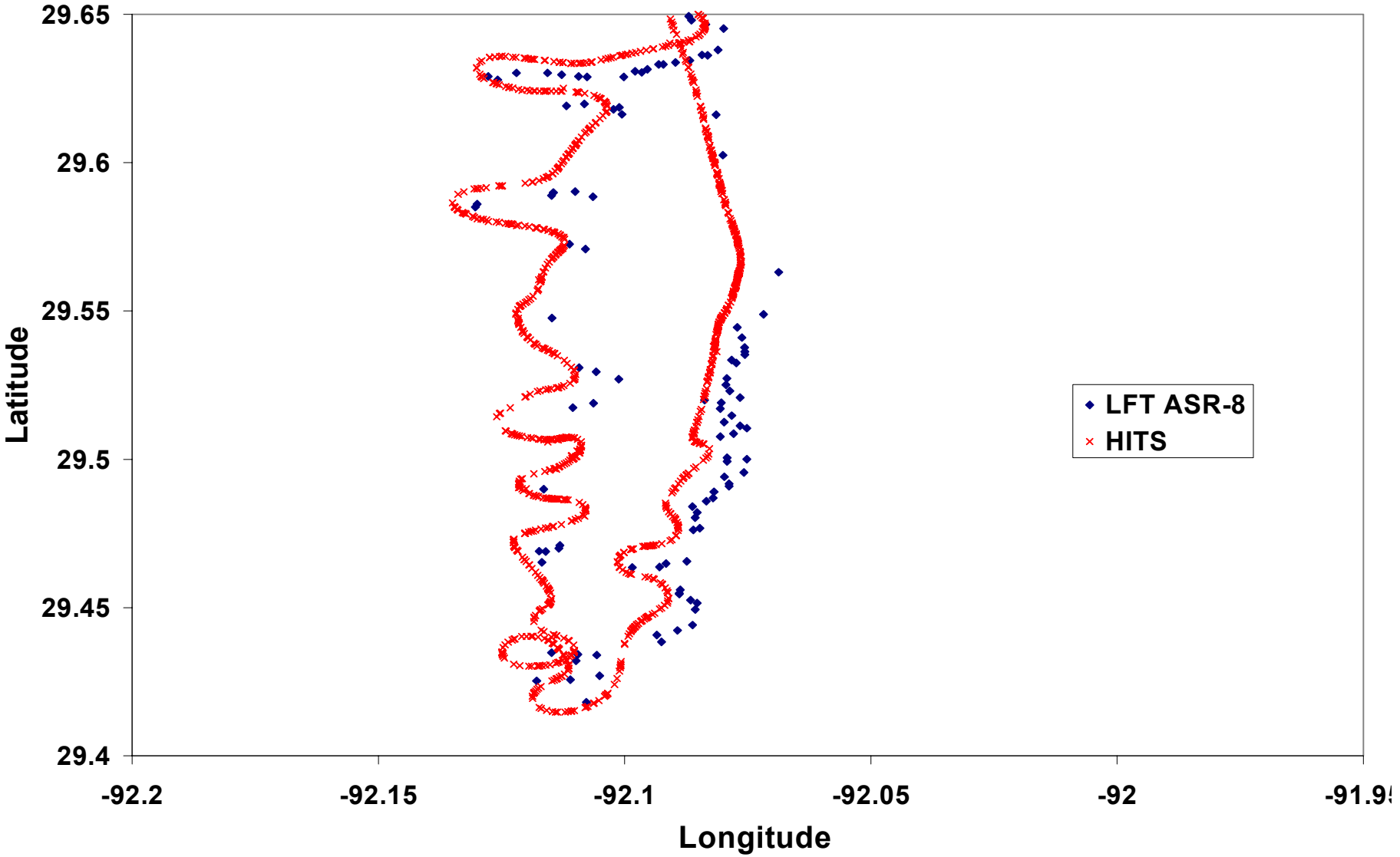


Multilateration v ASR – 8 Data

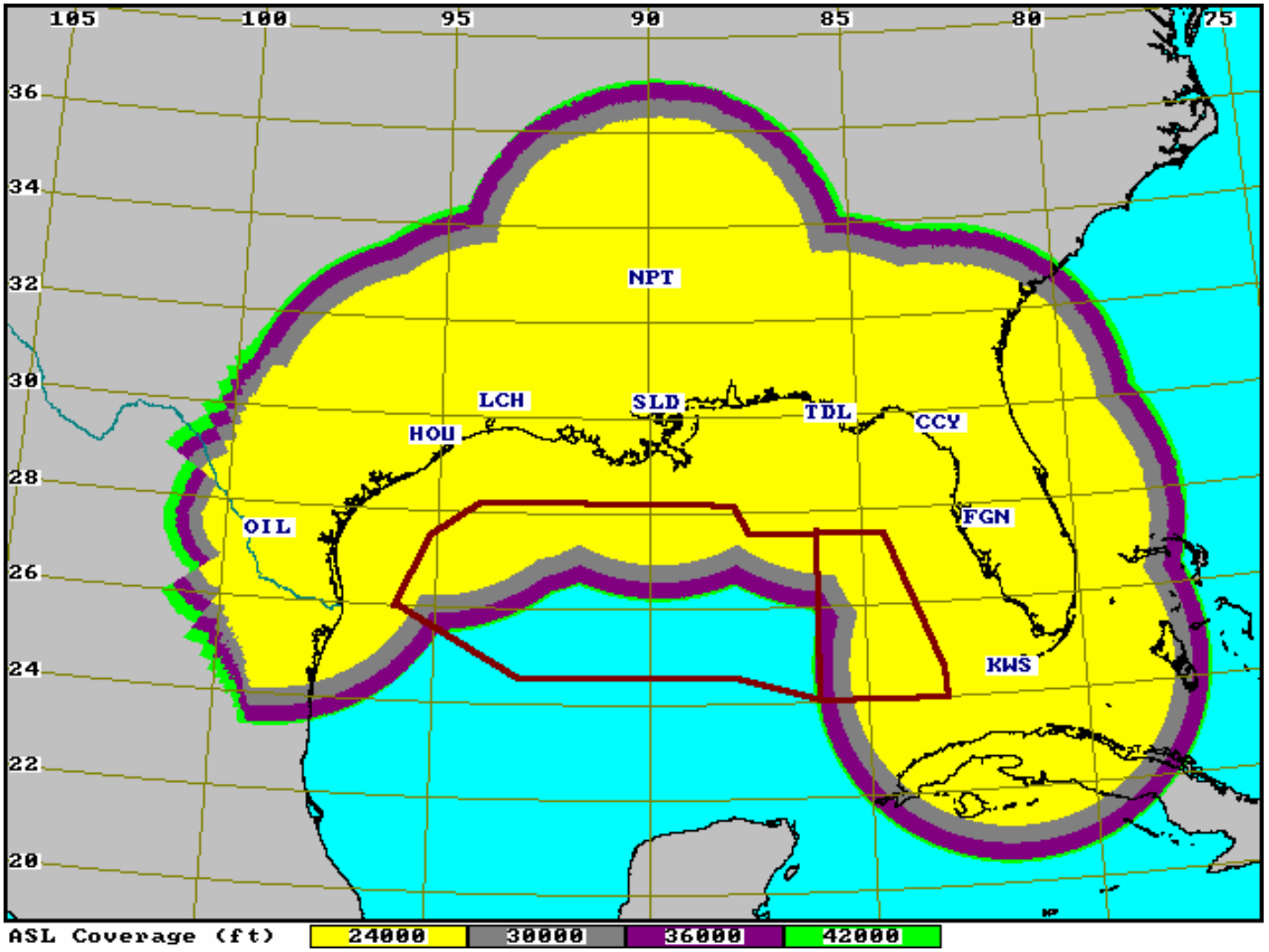




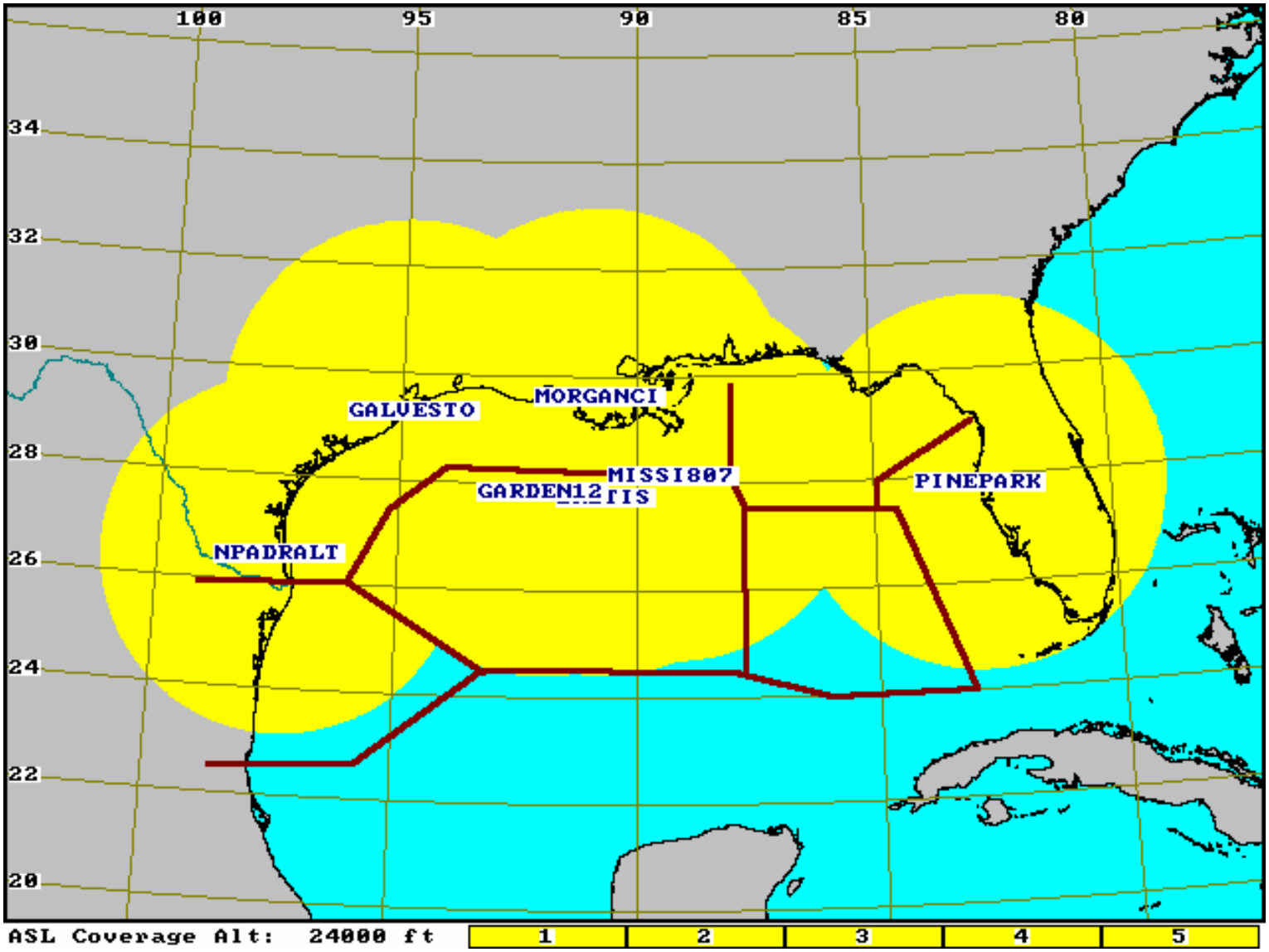
Target Resolution Multilateration v. ASR - 8



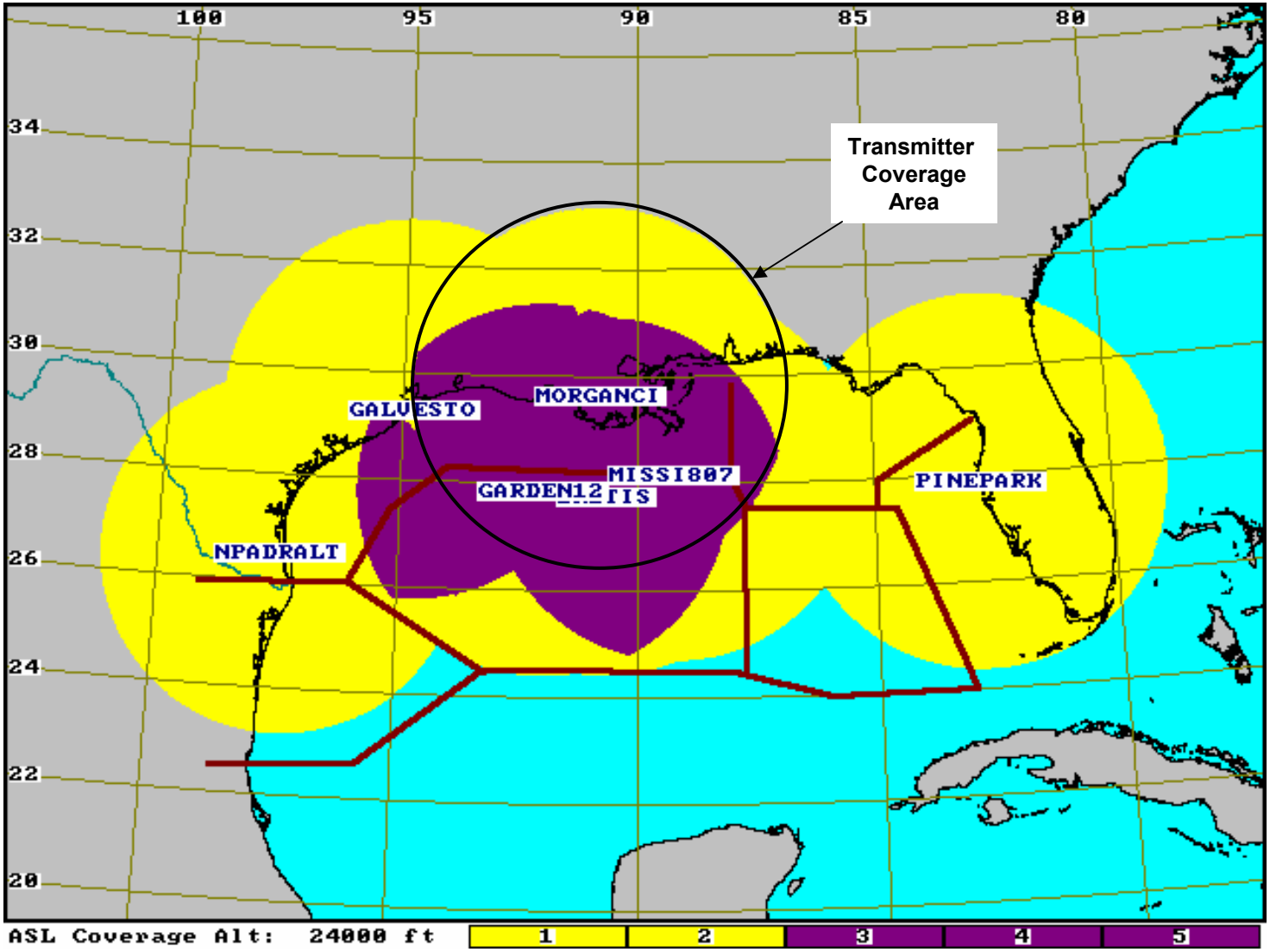
EnRoute Radar Coverage
Gulf of Mexico



ADS-B Coverage at FL280

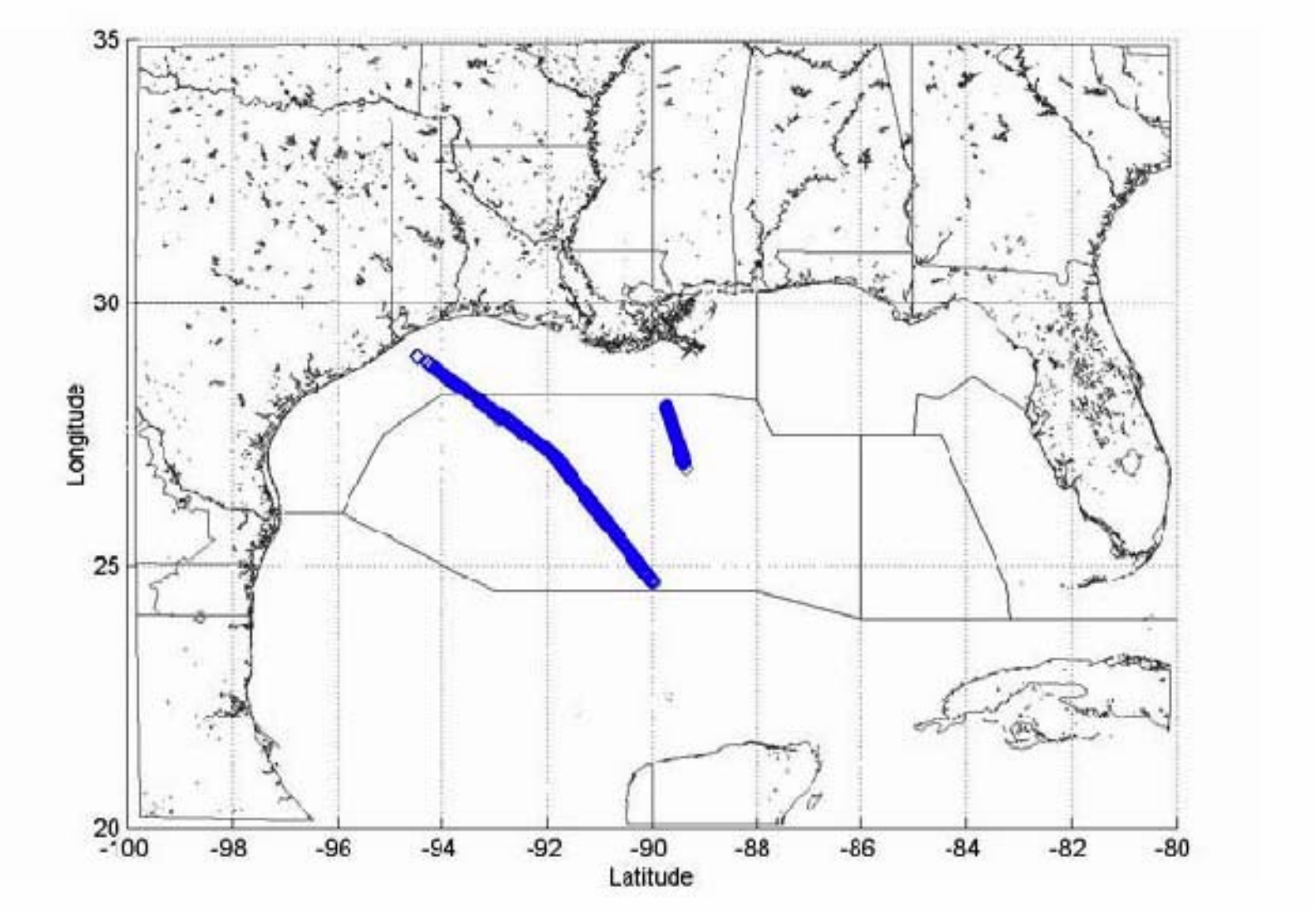


Multilateration Coverage at FL280



HITS II Remote Units

Wide Area Multilateration
N40 Track



Wide Area Multilateration
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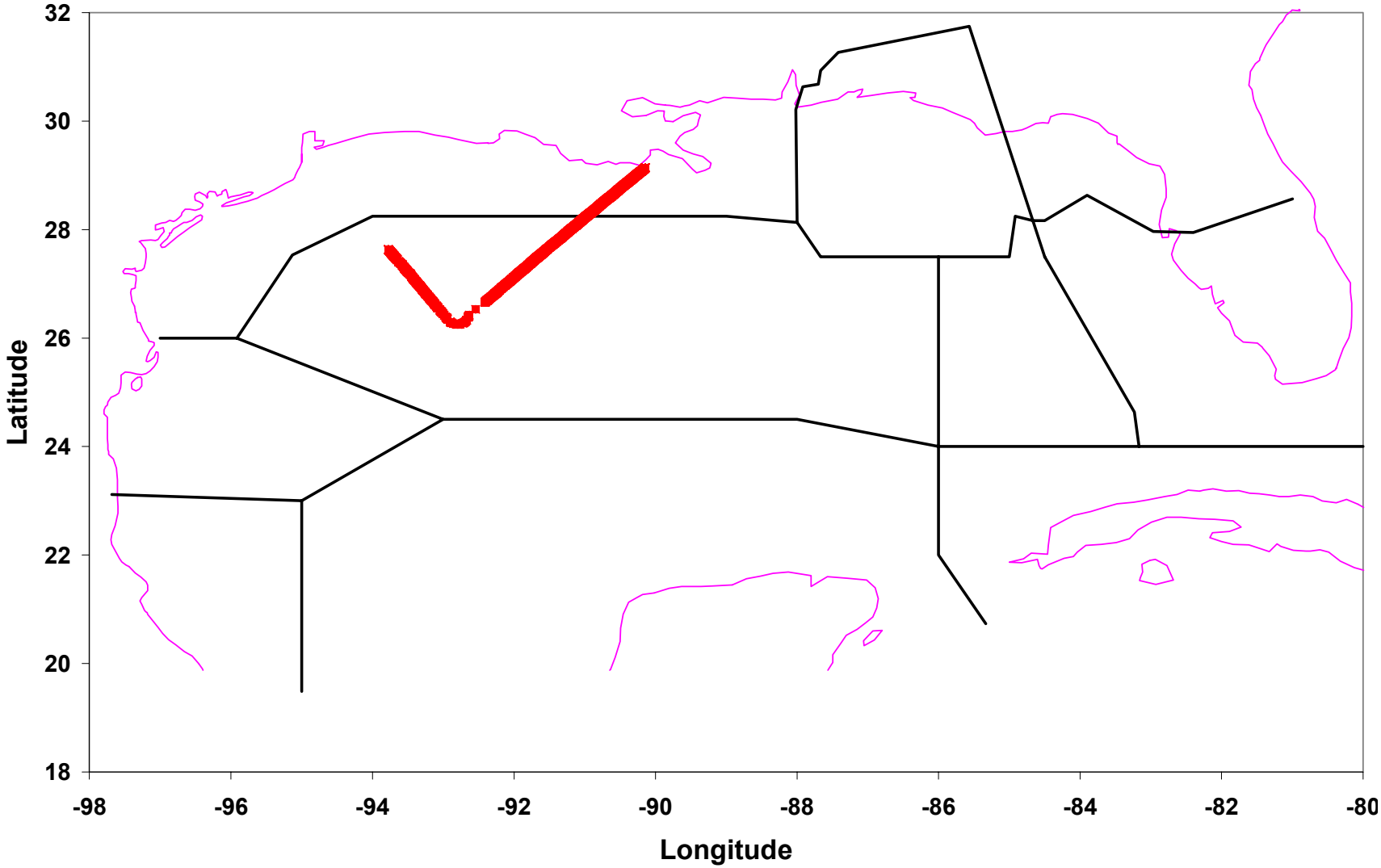
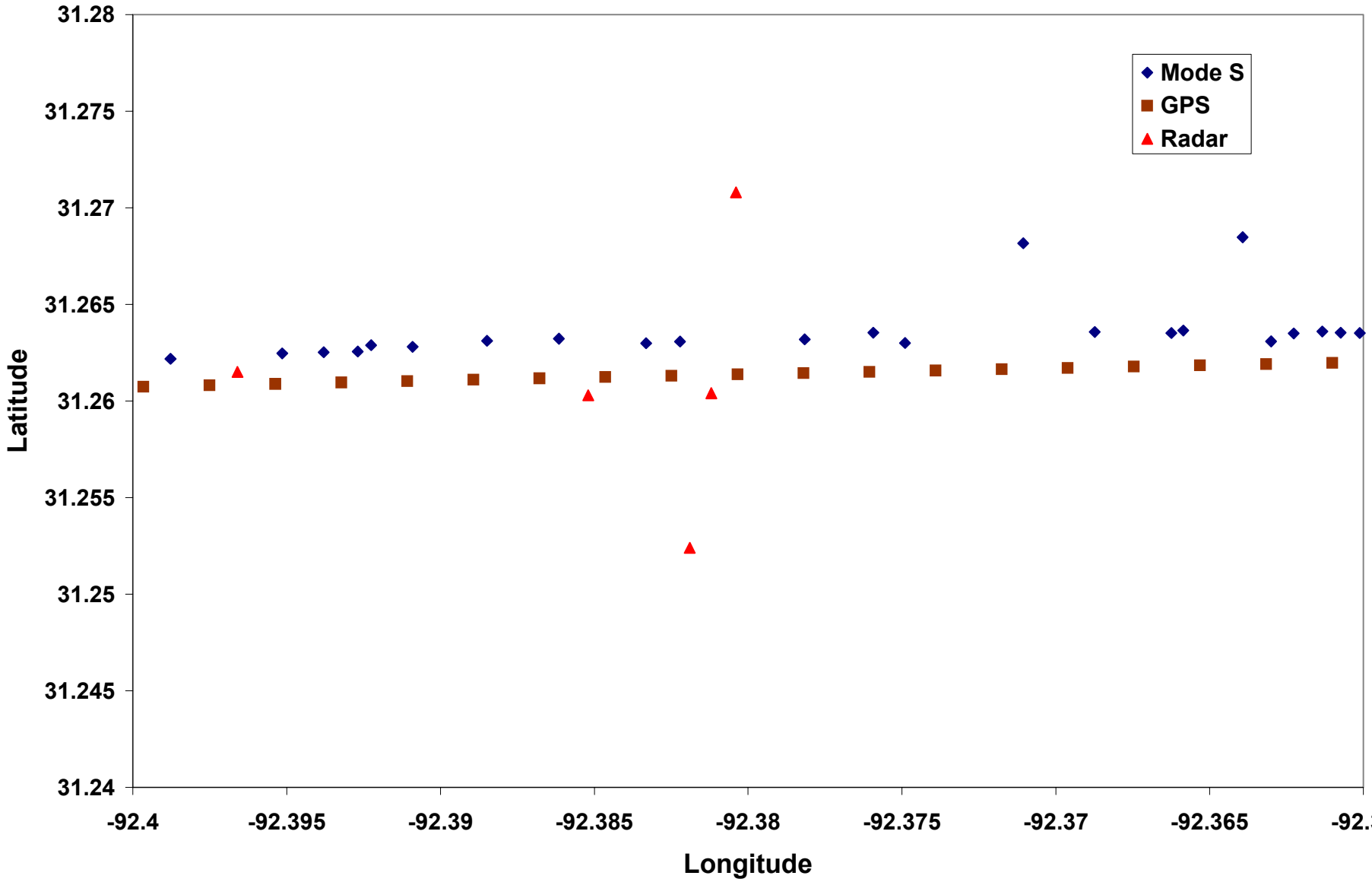
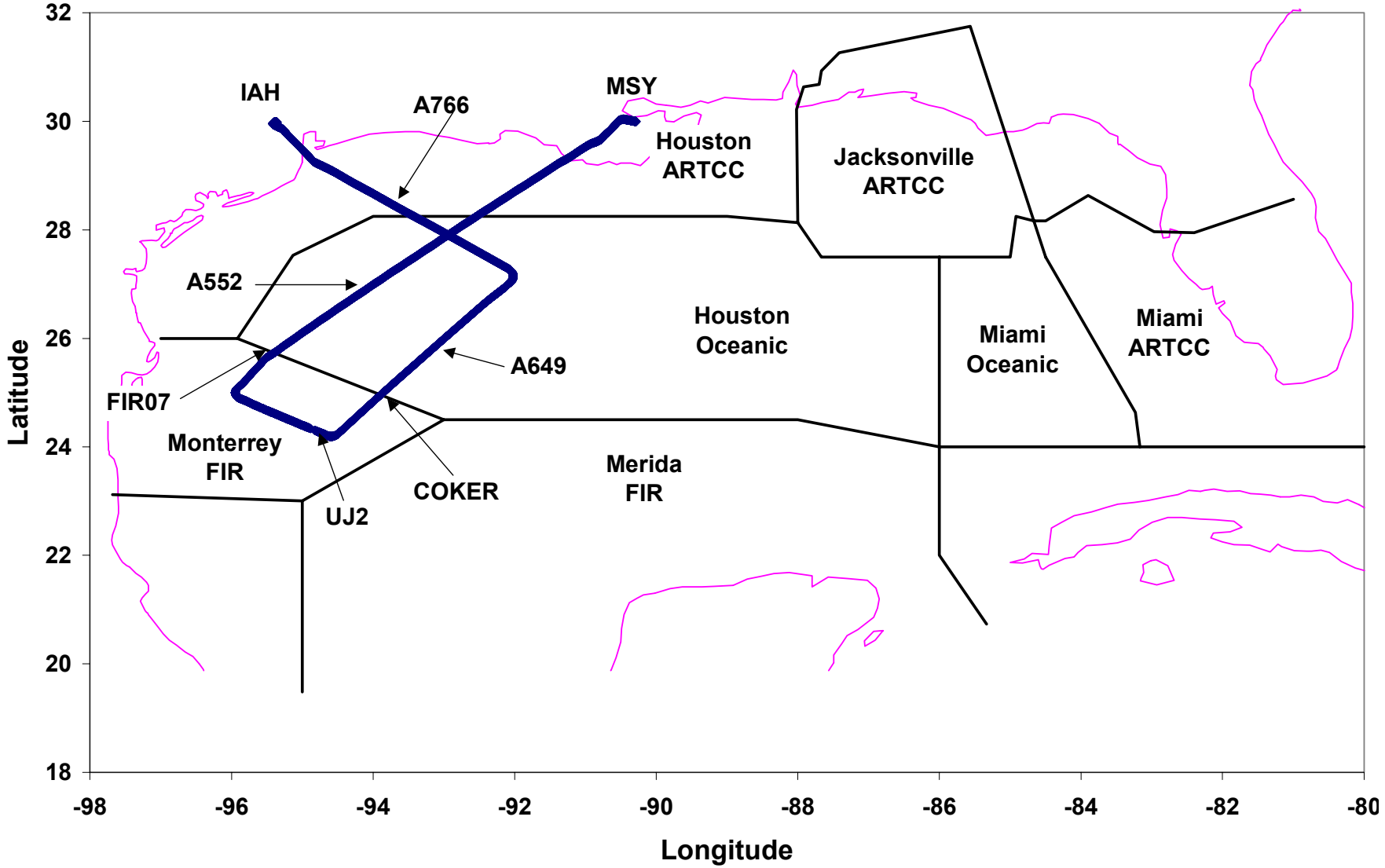


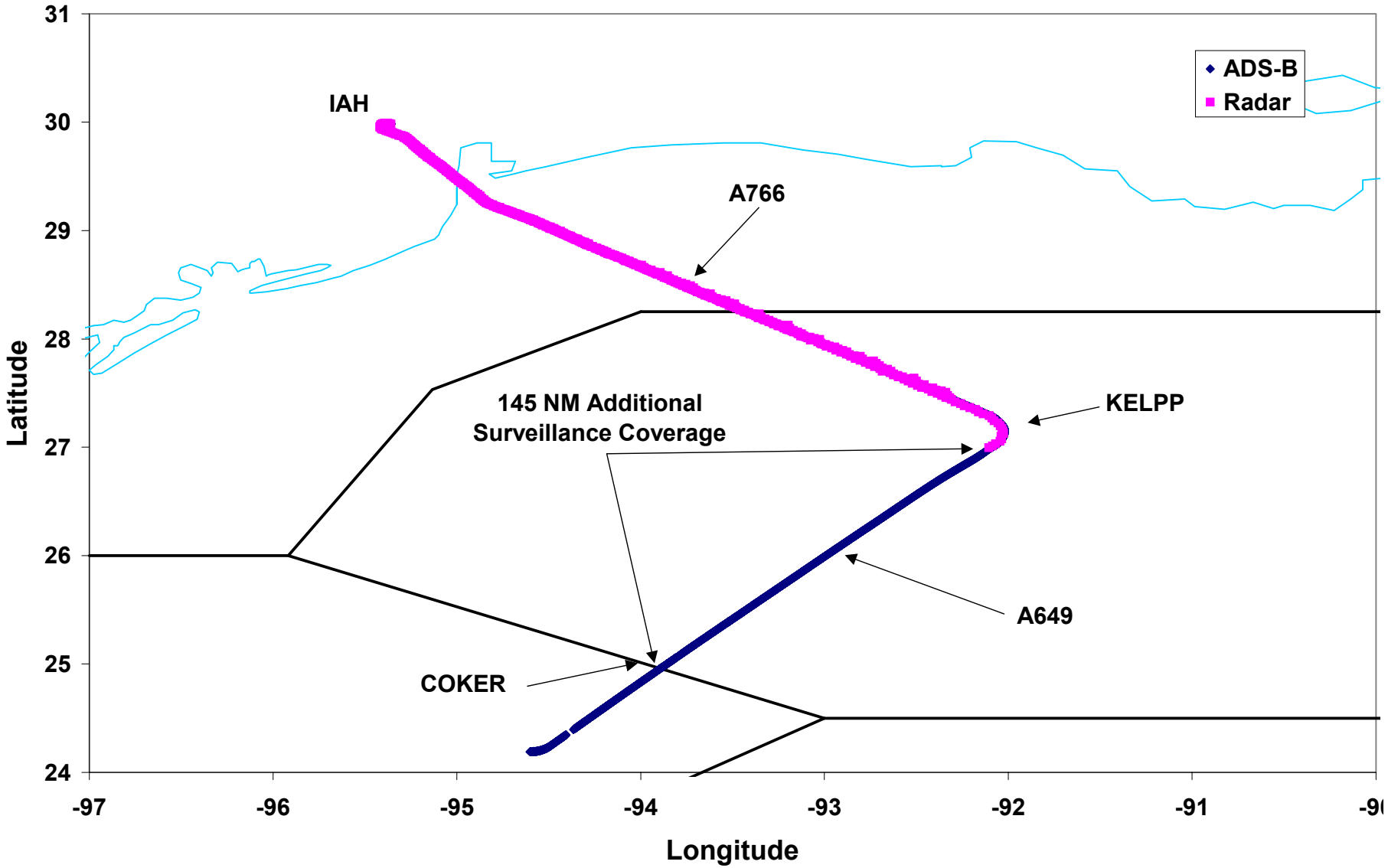
GPS, Multilateration, and Radar
Feb. 11 AM



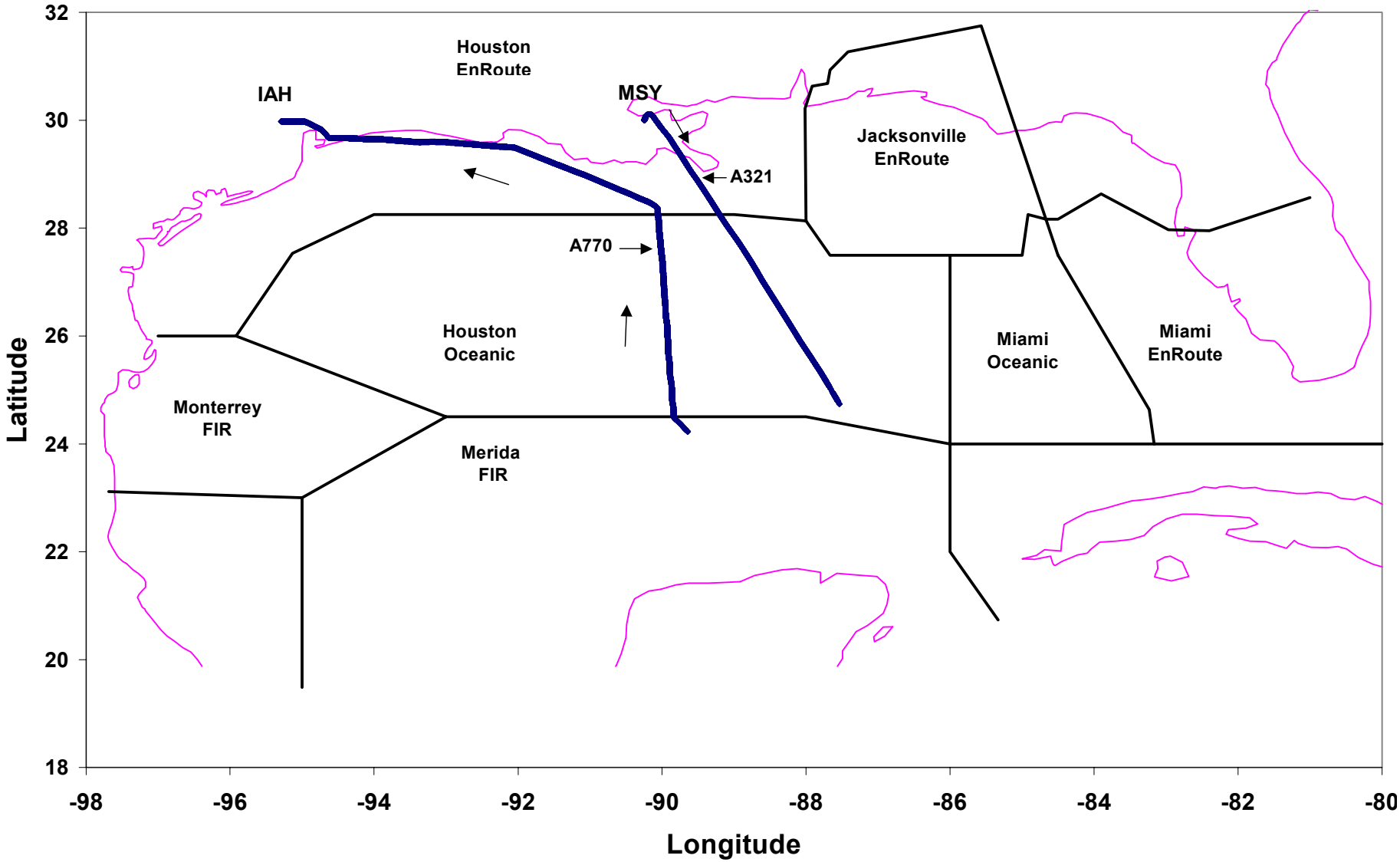
N40 Flight Test
IAH – MSY FL300



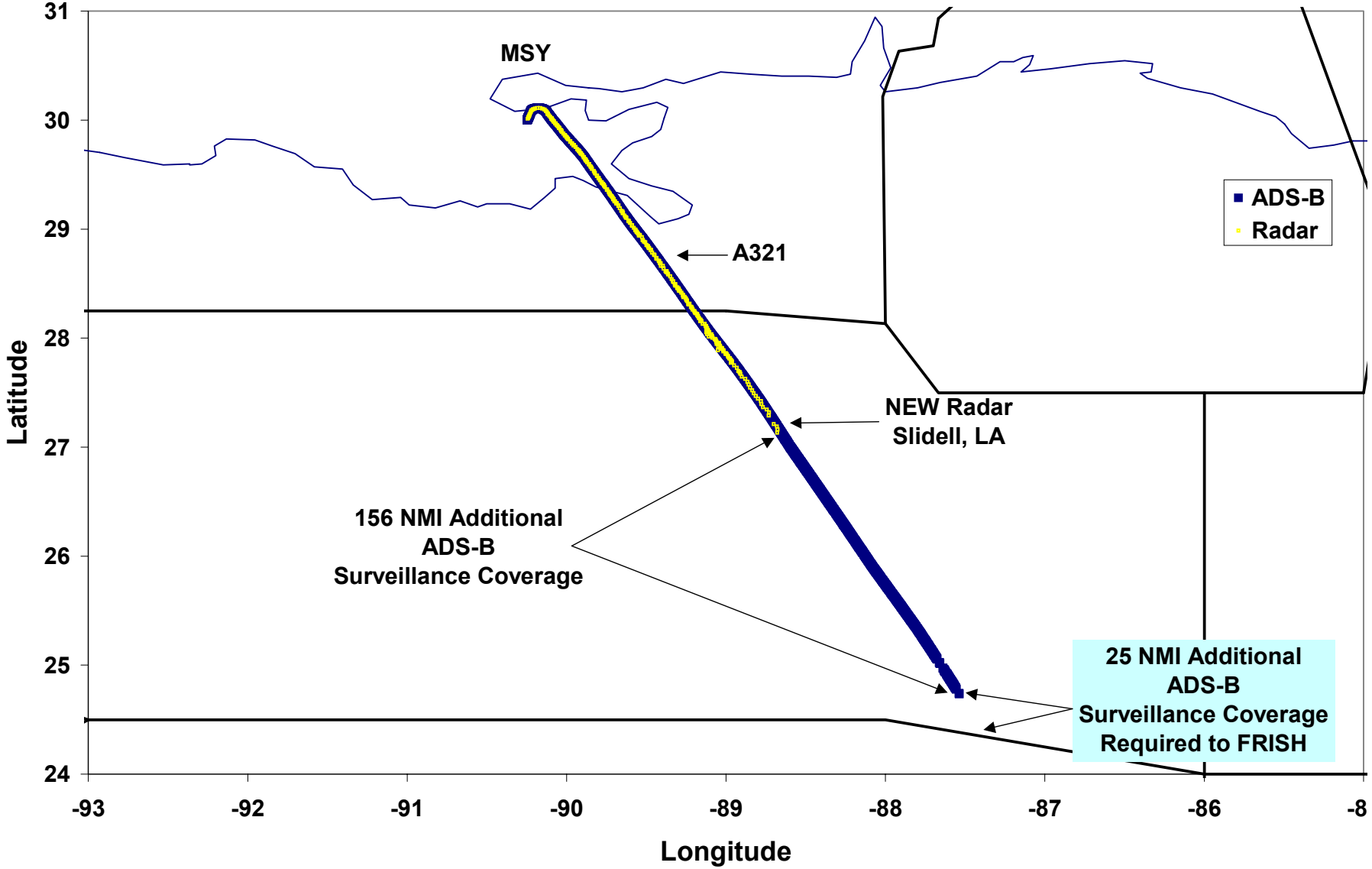
ADS-B v Radar Coverage



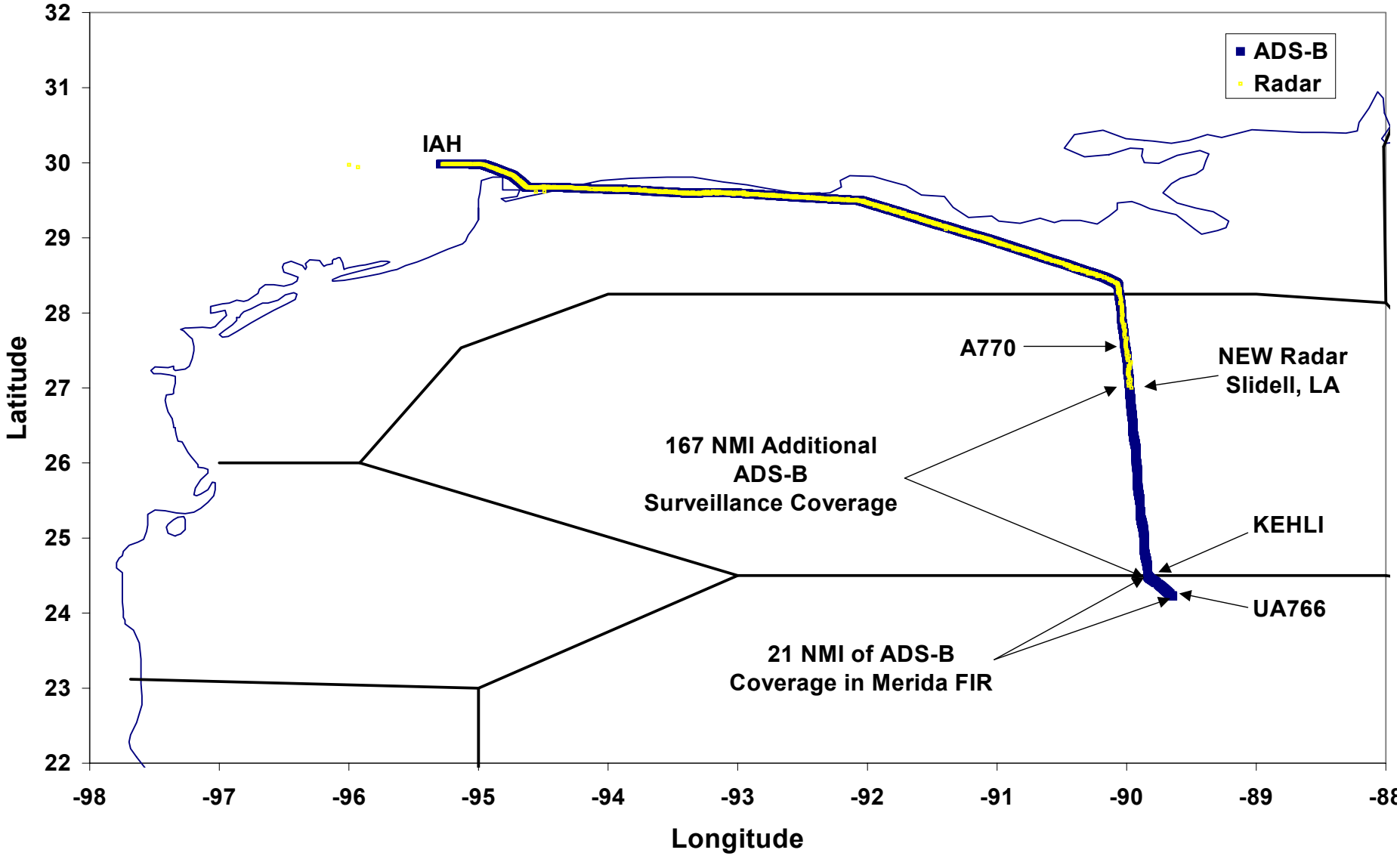
N40 Flight Test
MSY – IAH FL 280



ADS-B vs. Radar Data
Jan 7 PM Flight



ADS-B vs. Radar Data
Jan 7 PM Flight



ADS-B Performance

- **Range**
  - Remote Units (Brutus and Mars) performance limited by line-of-sight and not RF performance
- **Position Update Interval**
  - Update rates within 200 nmi well suited for EnRoute domain
  - For aircraft target beyond 200 nmi, ADS-B performance was ***outstanding***
- **Altitude Update Interval**
  - Aircraft altitude embedded in the ADS-B position message
  - Updates identical to position updates
- **Flight ID Update Interval**
  - HITS decoded aircraft Flight ID when present
- **False Targets**
  - No false targets observed in data
- **Velocity reports**
  - Velocity reports decoded by HITS but ASTERIX 10 message does not support dissemination to users
- **Special Pulse Indicator**
  - Flight testing indicated error w/some transponders outputting SPI in ADS-B message set

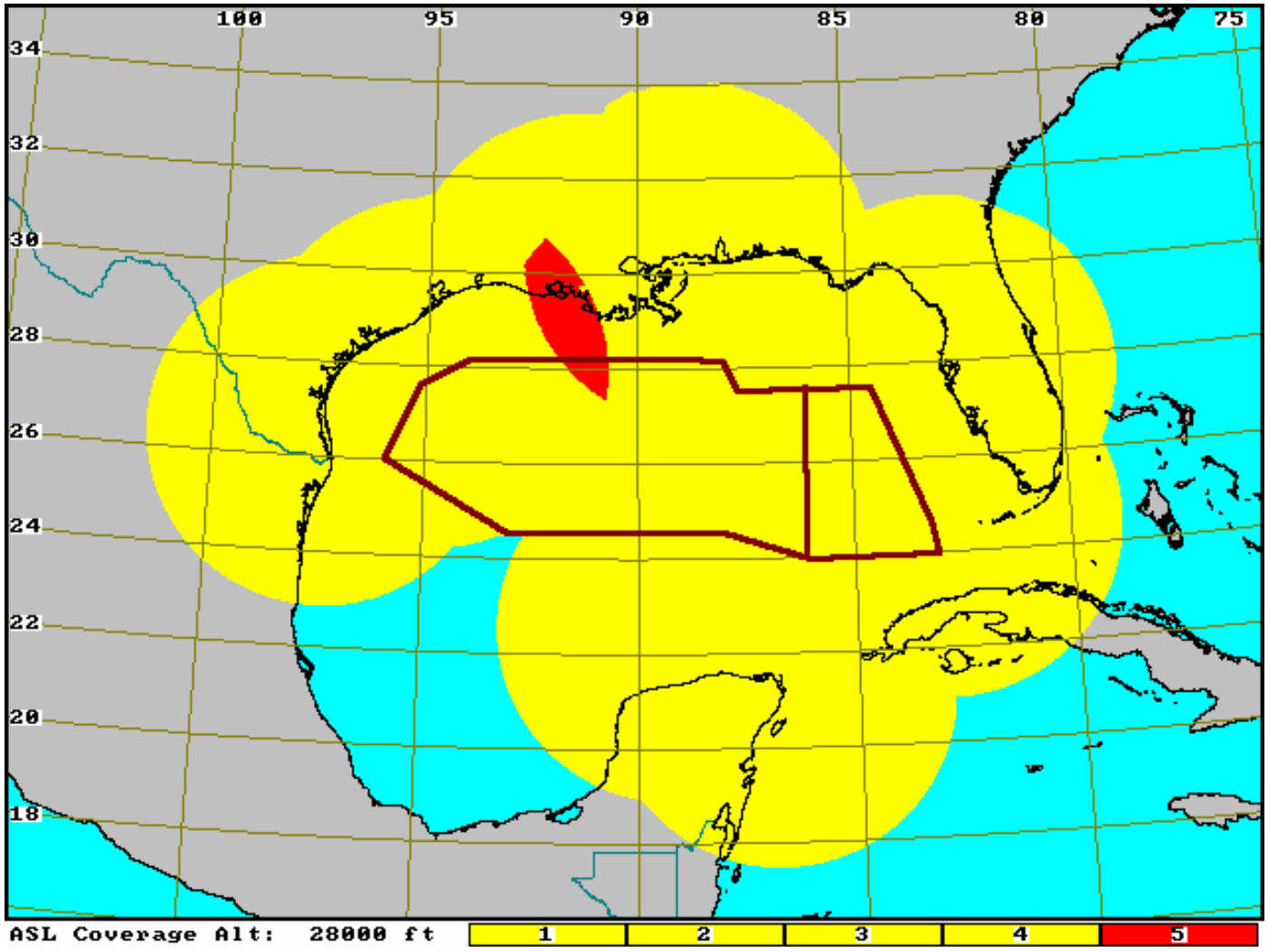
ADS-B Performance Observations

- **HITS provided coverage into Mexican FIR at the following EnRoute intersections:**
  - SWORD
  - FRISH
  - FIR07
    - N40 flew at FL370 for these tests
    - Need to validate performance in the March flight test to determine if performance related to anomalous propagation
- **Appears to be sufficient coverage for Houston Oceanic West Sector**
- **Houston East Sector however will require additional ground stations for improved performance**
  - FRISH/MYDIA not within HITS coverage area at FL280
- **Additional sights will be required west of Key West Fl, and the Yucatan Peninsula**

Next Steps

- **NASA R&D effort to assess multilateration and ADS-B has been completed**
  - Volpe Center will submit report detailing results since 2003
- **FAA's SF21 Program Office responsible for defining an architecture, Communication, Weather and Surveillance (CWS), for Low and High Altitude users**
  - Current HITS II configuration will remain in place until April 2005
- **For low altitude users, 1,500 ft minimum altitude for surveillance and voice communication coverage**
- **For high altitude users, FL280 minimum altitude coverage for surveillance and voice communication coverage**
- **Initial lay down of CWS equipment sited at Gov't facilities and major oil platform owners (per Memorandum of Agreement)**

Predicted High Altitude Coverage
Surveillance and Communications



Predicted Low Altitude Coverage

Surveillance and Communications